National Climatic Data Center

DATA DOCUMENTATION

FOR

DATASET 9670-9677 (DSI-9670-9677)

BOMEX

January 12, 2004

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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Table of Contents

1. Abstract: This report describes the data available from the BOMEX Permanent Archive, a depository for data collected during the Barbados Oceanographic and Meteorological Experiment (BOMEX) in 1969. Parameters included in this dataset are: boundary layer and surface air temperature, wet bulb temperature, humidity, and winds; clouds; visibility; precipitation; sea surface temperature; and waves. Procedures used in data processing are described, and an inventory of the archived data is given. With the cooperation of the Government of Barbados and with the National Oceanic and Atmospheric Administration as lead agency, the Barbados Oceanographic and Meteorological Experiment (BOMEX) was conducted over the tropical Atlantic East of Barbados in the summer of 1969. The field operations for this multiagency national study of the ocean-atmosphere system were divided into four observation periods: May 3 to 15, May 24 to June 10, June 19 to July 2, and July 11 to July 28. The first three were devoted to the Sea Air Interaction Program--the BOMEX 'Core Experiment'--within a 500-km by 500-km square ship array. During the fourth period, the array was extended southward to incorporate the Intertropical Convergence Zone.

Rawinsonde balloons launched from the BOMEX shipe carried two instrument packages aloft for each observation: A temperature sonde equipped with a thermistor and a humidity sonde with a hygristor. All sondes and telemetry units were of standard National Weather Service type with these exceptions:

(a) The temperature sondes were specially wired to yield only signals for temperature, low reference (190 Hz) instead of a humidity signal, and a special midreference signal (92 Hz) that replaces every fifth low reference in the sequence. This allowed more frequent reference signals and hence more precise corrections for variations in sonde characteristics. Selected precalibrated thermistors were used.

(b) The temperature sonde pressure sensors were specially selected and precalibrated twice at the factory, once “up” and once “down”. Sensors that showed large difference were rejected.

(c) The humidity sondes were modified to yield an almost continuous humidity signal, interrupted only occasionally for low-reference signal. Because the humidity data are much less sensitive to minor sonde battery variation that the temperature data, there was no need for frequent reference checks. A more sensitive uncalibrated pressure commutator was substituted for the usual baroswitch to further shorten the time occupied by reference signals. All pressure data were taken from the temperature sonde and time correlated to the humidity data. The net result was extraordinary fine vertical resolution in the humidity profile.

Temperature sonde and humidity sonde signal output was acquired by separate receivers aboard ship and recorded automatically on the Signal Conditioning and Recording Device (SCARD), the primary shipboard recording unit, which was developed and operated in the field by personnel form NASA’s Mississippi Test Facility (MTF). Data were also recorded on strip charts for quality control.

Two types of balloon-tracking systems were used: the Scanwell Wind Finding at Sea System (WFSS) and radar wind finding systems. The data were also recorded on SCARD, as well as on strip charts for quality control.

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BOOM

The five fixed ships used as observation platforms were the U.S. Coast and Geodetic Survey ships Oceanographer, Rainier, Mt. Mitchell, Discoverer, and the U.S. Coast Guard cutter Rockaway. The mooring system designed to maintain the ships at their designated locations failed -- the Mt. Mitchell's and Rainier's at the very beginning of period I, the Rockaway's early in period II, and the Oceanographer's and Discoverer's later during the same period. After mooring failure, the ships used various modes of steaming and drifting in an attempt to remain as close as possible to their assigned positions. More than 2,500 rawinsondes were released during BOMEX from the five ships, with surface temperature, humidity, and wind being measured both manually by observers aboard ship and electronically by sensors mounted on a boom extending from the bow of each ship. This memorandum presents a preliminary comparison of the first 200 m of the rawinsonde temperature data to determine (1) whether the ships' effects might have contaminated the lower levels of the rawinsonde data and (2) if contamination is evident, whether use of the electronically measured surface temperature data would tend to reduce or eliminate the contamination.

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Salinity-Temperature-Depth Data Set (STD) instruments were casts from the surface to 1,000m. The instrument’s underwater signals were frequency modulated and multiplexed so that salinity, temperature, and depth measurements were transmitted through the lowering cable as a single composite wave form. These were scheduled for the Discoverer, Oceanographer, and Rockaway at 0100, 0300, 0600, 0900, 1200, 1500, 1800, and 2100 GMT; during Period IV, however, the first sounding from the Discoverer was made at 0000 rather than 0100. Soundings from the Mt. Mitchell and Rainier were scheduled at 0100, 0600, 1200, and 1800 GMT. All schedules were adhered to within ±30 min. The sensor package was soaked at the surface for 5 min., lowered at a rate of approximately 20m/min to 100m, and then allowed to descend at 40 to 50m/min. The depths were determined from the STD strip-chart recorder on deck. Data were recorded during each descent only.

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The data collected by the RFF aircraft were assigned a flight identification (ID) number for the every mission flown. This number is made up of the year, month, and day, and a letter designating a particular aircraft. The letter “A” was used for the DC-6 39C; “B” for the DC-6 40C; and “E” for the DC-4 82E. An extra digit at the end of the flight ID number indicates the number of missions flown in one day, e.g., flight number 690526B1 means that the DC-6 40C was flown on May 26, 1969.

The original meteorological data were recorded aboard the aircraft at the rate of one record every second. Each record consists of 150 characters. There are approximately 10 to 12 hours of data, i.e., 36,000 to 44,000 records, per flight. No record counts are available, but each observation is distinguished by time in hours, minutes, and seconds. Some of the parameters included are air pressure, radar altitude, vortex temperature, differential pressure, drift angle, dew point, and ground speed.

Data collected by the Navy and Air Force Aircraft.

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TD-9675

Spectral Analysis of wind time-series data obtained with the Boundary Layer Instrument Package (BLIP) during the Barbados Oceanographic and Meteorological Experiment (BOMEX) in 1969 shows the spectra to be contaminated by ship and balloon motion only at the very high frequencies (0.11 to 0.07 Hz). Spectra for undisturbed weather show the existence of weak eddies with wavelengths centered near 300 m, while those for disturbed conditions indicate energetic two-dimensional eddies with wavelengths of up to several hundred meters. One of the objectives of the Barbados Oceanographic and Meteorological Experiment (BOMEX), held in the summer of 1969, was to gather information about the marine tropical planetary boundary layer. Since the experiment was to take place on the open sea, standard instrumentation and techniques could not be used, The need for specially designed instrumentation gave birth to the Boundary Layer Instrument Package (BLIP), which was developed for BOMEX by the University of Wisconsin. The BLIP is a modified radiosonde that was launched by a tethered balloon during the first three BOMEX observation periods from the four corner ships and from the Oceanographer and Mt. Mitchell during the fourth observation period. It consist of a three_cup anemometer mounted on an A-frame that acts as a wind vane, with temperature, humidity, and pressure sensors contained in a package attached to the bottom of the frame. A detailed description of the instrumentation has been given by Almazan (1972). The data obtained by the BLIP are likely to be contaminated by ship movement, balloon motion, and the interaction between the balloon and the tether line. The purpose of this study is to separate the effects of such motion from meteorological scales of motion using spectral analysis of BLIP data for both undisturbed and disturbed weather conditions.

TD-9676

Surface weather radar data were collected from two observation stations: (1) the inland of Barbados west of the BOMEX array, and (2) aboard the NOAA ship Discoverer, located at the southeast corner of the BOMEX fixed-ship array.

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Dropsonde observations were made during reconnaissance flights by USAF Air Weather Service WC-130 aircraft operated by the 53rd Weather reconnaissance Squadron, Ramey Air Force Base, Puerto Rico. During the first three BOMEX Observation Periods, day and night missions were flown. On each flight, eight dropsondes were released from an altitude of 20,000 ft. Dropsonde release times were nominally between 0130 and 0600 GMT at night and between 1300 and 1830 GMT during the day. In addition, on May 6, 13, and 28, June 26, and July 1, 1969, eight daytime soundings at 30 min intervals were made over position DELTA, the station of the NOAA ship Mt. Mitchell, for comparison with the ship rawinsonde observations.

During BOMEX Period IV, the drop positions, flight altitudes, and observation times varied with the objective of each day’s mission.

Of a total of 488 soundings, 438 could be recovered and were processed. The remaining 50 soundings were not processed because of bad, missing, or noisy data resulting form instrument or recorder malfunctions, interference, or weak signals.

Following the field operations, the Barbados Oceanographic and Meteorological Analysis Project (BOMAP) Office was established to reduce and process the data

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that had been collected by ship, aircraft, and land-based acquisition system under the operational control of the BOMEX Temporary Archive at the National Climatic Data Center (NCDC) in Asheville, N.C., in 1971. On July 1,1971, the BOMEX office became the Center for Experiment Design and Data Analysis (CEDDA) and was subsequently transferred from NOAA's Environmental Research Laboratories to its Environmental Data Service. One of the tasks assigned to CEDDA--in addition to its participation in other field experiments, was to reprocess the BOMEX data. Final validation of the data was undertaken through detailed analysis and application of necessary corrections, a task that was completed in the fall of 1974, when the BOMEX Permanent Archive was established at NCDC.

2. Element Names and Definitions:

Rawindsonde Data
TD-9671

The data file is divided into four sections: (1) 5-s or significant levels; (2) 10-mb surfaces; (3) standard pressure surfaces (1,000, 950, 900, 850,…mb) and (4) standard aircraft operating levels (305, 1,220, 2,135, and 3,040 m). Each section has a header, which indicated the number of valid counts, and a variable number of data scans of 1,300 characters.

Word	Format	Data element	Units
1	F7.1	Time from launch	Seconds
2	F7.1	Pressure	Millibars
3	F6.1	Temperature	Degrees Celsius
4	F6.1	Relative Humidity	Percent
5	F5.1	Specific Humidity	Grams per kilogram
6	F5.1	Dewpoint	Degrees Celsius
7	F6.1	Relative humidity	Percent
8	F5.1	Saturated vapor pressure	Millibars
9	F5.1	Vapor pressure	Milibars
10	F5.1	Specific Humidity	Grams per kilogram
11	F5.1	Dewpoint	Degrees Celsius
12	F6.1	Virtual Temperature	Degrees Kelvin
13	F7.1	Thickness	Meters
14	F8.1	Geopotential Height	Meters
15	F8.1	Geometric Height	Meters
16	F6.1	Potential temperature	Degrees Kelvin
17	F6.1	U wind component	Meters per second

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18	F6.1	V wind component	Meters per second
19	F6.1	Wind direction	Degrees
20	F5.1	Windspeed	Meters per second
21	F5.1	U component, ship motion	Meters per second
22	F5.1	V component, ship motion	Meters per second
		999 = missing data	

Boom Data
TD-9672

The final 2-spm boom data area received on a seven track, 556 BPI, BCD magnetic tape, as well as on microfilm. The first file consists of ANSI standard label, followed by end-of-file. The second file consists of an 80-character descriptive tape header, followed by end-of-file. The third file is repeated for each day. It consists of one or more data records each 1,540 characters long, and is preceded by a header record and followed by an end-of-file. The 350-character header record identifies the data by tape, ship name, and Julian day. A double end-of-file follows the last data file on the tape.

STD
TD-9673

The first recording in each file contains information concerning that particular sounding. The following records contain time-series STD data recorded during that sounding. File organization is repeated as necessary, with one file per STD sounding. A double end-of-file mark is written after the last file on the tape.
The header record is intended to fully describe the data contained within that file. Each record contains:

Description of data records.
Ship name.
Date and time of sounding.
Geographic location of sounding.
Instrument model and serial number.
Transfer equation for sensors.
Transfer constants for sensors.
Pertinent comments about the sounding.

Field Number	**Character Position Description**	
Card Image 1		
001	001	Carriage control '1'
002	002-011	'BOMEX STD'
003	012-025	Ship name
004	026-029	'Year'
005	030-034	Year '1969'
006	035-038	'Day'
007	039-042	Julian day of year
008	043-047	'Time'
009	048-050	Hour of start of

:
:

		cast
010	051	Blank
011	052-053	Minute of start of cast
012	054-062	'GMT LAT'
013	063-064	Latitude degrees
014	065	Blank
015	066-067	Latitude minutes
016	068	Latitude direction 'N'
017	069-073	'LON'
018	074-076	Longitude degrees
019	077	Blank
020	078-079	Longitude minutes
021	080	Longitude direction 'W'
Card Image 4		
001	001	Carriage control 'blank'
002	002-080	Description of data format
Card Image 5		
001	001	Carriage control '0'
002	002-031	Text
003	032-035	STD model number
004	036-043	Frame serial number
005	044-047	STD serial number
006	048-080	Frequency conversion equation
Card Image 6-8		
001	001	Carriage control 'blank'
002	002-012	Sensor: 'SALINITY', 'TEMPERATURE', or 'PRESSURE'
003	013-017	'SN='
004	018-021	Sensor serial number
005	022-025	'Z='
006	026-034	Zero frequency
007	035-036	'S='
008	037-046	Slope
009	047-048	'C='
010	049-058	Y-intercept
011	059-080	Units: PPT, °C, or 'DECIBARS'
Card Image 9-13		
001	001	Carriage control '0'
002	002-080	Comment pertinent to data in file

Card Image 14-20		
001	001	Carriage control '0'
Card Image 2		
001	001	Carriage control '0'
002	002-080	Description of data format
Card Image 3		
001	001	Carriage control '0'
002	002-080	Description of data format

RFF
TD-9674

The RFF meteorological data are archived on 800 BPI, BCD magnetic tape. The length of each record is 2,080 characters. The format of each record is as follows.

Field	Character	Element
1	1-6	Air pressure
2	7-12	Radar altitude
3	13-17	Heading
4	18-24	APN-82 distance travel count
5	25-28	APN-82 drift angle
6	29-33	Vortex temperature
7	34-38	Infrared hygrometer
8	39-43	Differential pressure
9	44-47	APN-153 ground speed
10	48-51	APN-153 drift angle
11	52-56	Rosemount temperature
12	57-61	CSI dewpoint
13	62-66	Liquid water content
14	67-68	APN-82 and APN-153 memory
15	69-71	Julian Day
16	72-73	Hour
17	74-75	Minute
18	76-77	Second
19	78-81	U (positive east) wind component
20	82-85	V (positive north) wind component
21	86-89	Temperature
22	90-93	Absolute humidity
23	94-97	Liquid water content
24	98-102	Pressure
25	103-107	Altitude
26	108-114	Latitude (positive north)
27	115-121	Longitude (positive south)
28	122-125	Ground speed
29	126-129	True heading

:
:

30	130	(9) Dummy character

Navy and Air Force Aircraft

Weather reconnaissance data obtained by Navy WC-121 and Air Force WB-47, RB-57, and WC-130 aircraft were recorded on the BOMEX RECCO Code (Aerial Meteorological Reconnaissance Reporting Code) Form. Navigation data were also manually recorded aboard these aircraft.

The NAV data consist of manual observations of aircraft altitude, airspeed, and heading; drift angle and ground speed; pressure and temperature; and indicated wind direction and windspeed uncorrected for Doppler radar errors and the variation of airspeed with density. The observations were frequently made in rapid succession during long, straight flight paths, and during each leg of a "wind box". No other processing or error checks were done. Airspeed is uncorrected for density; ground speed and drift angle are not corrected by wind-box or intercomparison data; and windspeed and wind direction are uncorrected for airspeed, heading, ground speed, and drift-angle errors.

The format of the RECCO data is as follows:

Data Element	**Format**	**Code Reference**
Time	F4.0	
Humidity indicator Day of week Octant of globe	F3.0	Table 2 Table 3 Table 4
Latitude	F3.0	LaLaLa
Longitude	F3.0	LoLoLo
Flight conditions	F1.0	Table 6
Altitude	F3.0	hhh
Type of wind Reliability of wind	F2.0	Table 7 Table 8
Wind direction	F2.0	dd
Wind Speed	F3.0	fff
Temperature	F3.1	TT.T
Dewpoint	F3.1	TT.T
Present weather Remarks on present weather	F2.0	Table 9 Table 10
Index pertaining to HHH	F1.0	Table 11
HHH (Altitude or other data)	F3.0	HHH
Cloud amount group indicator No. of cloud layers Cloud amount layer 1 Cloud amount layer 2 Cloud amount layer 3	F5.0	Table 12
Cl cloud type Altitude of base Altitude of top	F5.0	Table 13 Table 14 Table 14
C2 same as C1	F5.0	
C3 same as C1	F5.0	
VSFC group indicator Direction of surface wind Speed of surface wind Group indicator	F8.0	

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Surface wind direction Surface wind force		Table 15 Table 16
AMISC state of sea Direction of swell Group indicator Significant change in WX Distance of occurrence Weather off course Bearing WX off course	F7.0	Table 17 Table 15 Table 18 Table 19 Table 20 Table 15
Sea surface temperature	F3.1	
Pressure indicator	F1.0	
Altitude indicator	F1.0	
Aircraft indicator	F1.0	
Date	F3.0	

The format of the NAV data is as follows:

Character	**Data Element**	**Units**
1	Data type	
2-4	Location	
5-8	Observation time	Month
9-10	Observation time	Day
11-13	Latitude	Degrees
14-15	Latitude	Minutes
16-18	Longitude	Degrees
19-20	Longitude	Minutes
21-23	Observation time	Hours
24-25	Observation time	Minutes
26-31	Aircraft altitude	Feet
32-35	Aircraft heading	Degrees
36-39	Drift angle	Degrees
40-43	Ground speed	Knots
44-49	Pressure altitude	Feet
50-52	Pressure altitude indicator	Significance unknown
53-57	Temperature	Degrees Celsius
58-61	Airspeed	Knots
62-64	Airspeed indicator	Significance unknown
65-68	Wind direction	Degrees
69-71	Windspeed	Knots
72-77	Observation No.	

BLIP Data
TD-9675

The archived BLIP data include the following measured meteorological parameters:

Windspeed
Wind Direction
Dry-Bulb temperature
Wet-Bulb temperature
Pressure or relative humidity.

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Included also are derived values for:

Wind u component
Wind v component
Relative humidity from dry- and wet-bulb differences.

Each file header contains the following:

Record 1, which gives ship name, phase number, and run number.
Record 2, which gives Julian day, run number, and ship number.
Record 3 and 4, which contain the following headers and units that describe the data in the data record.

Element	Header	Description
1	Time A	GMT time in seconds Blank
2	Speed B	Windspeed in meters per second. Windspeed label, S indicating suspect data.
3	DIREC C	Wind direction in degrees. The corrected wind direction was obtained by comparing the mast wind direction with the BLIP wind direction and adding a bias, if needed, to the direction as measured by the BLIP. Wind direction label, S indicating suspect data.
4	U	East-West wind component
5	V	North-South wind component
6	N	Number of samples used in computing the l-s average for windspeed and wind direction.
7	TDB D	Dry-bulb temperature in degrees Celsius. Dry-bulb temperature label, S indicating suspect data.
8	TWB E	Wet-bulb temperature in degrees Celsius. Wet-bulb temperature, S indicating suspect data.
9	PR/RH1	Pressure in millibars for the Mt. Mitchell Period II, and pressure in “levels” for all baroswitch measurements;

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		for time and pressure in millibars. RH1 is the relative humidity in percent measured by the carbon hygristor.
	F	RH1 value label, S indicating suspect data.
10	RH2	Relative humidity in percent computed from the dry- and wet-bulb differences. A constant pressure value of 1,000 mb (not the actual surface pressure not the pressure at flight level) was used in the computation of RH2.
11	N	Number of samples used in computing 1-s averages of temperature and RH1
	G	Blank

There are 14 data sets in each data record. The format of the data record is as follows:

Element	**Character Position**	**Description**
1	1-6	Time
A	8	Dummy
2	10-15	Windspeed
B	17	Flag
3	20-24	Wind direction
C	26	Flag
4	28-33	U component
5	35-40	V component
6	42	N
7	44-49	Dry bulb
8	53-58	Wet bulb
E	60	Flag
9	62-68	Pressure or relative humidity
F	70	Flag
10	72-76	Computed relative humidity
11	78	N
G	80	Dummy

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Surface Radar Composites
TD-9676

An end of file separated these header records from the data files. An input module is included at the end of the file. Each photo is a composite and there is an end of file after each photo with a double end of file at end of data. The file for each photo is constructed as follows. Physical record 1 contians 30 right justified 10 character BD words. Each word can be decoded via an I10 format.

1. Photo number from gain step 1.
2. Photo number from last gain step in a sequence.
3. Julian date
4. Time of first photo.
5. Time of last photo.
6. Last photo sequence code.
7-12. Gain steps 1 through. (Recorded in -DBM).
13. Antenna tilt is degrees.
14. Latitude.
15. Longitude.
16. Ground clutter range.
17. Fiducial angle.
18. Fiducial distance.
19. Radar number.
20. Scale factor times 100.
21. STC, 0 = Off, 1 = On
22. Number of composite points.
23. Reserved
24. Percent of accuracy.

Dropsonde
TD-9677

The final BOMEX dropsonde data are available on magnetic tape and microfilm. The magnetic tape contains five separate data sets for each sounding. Information about the tape itself, the content of each set and the format used to place it on tape are given in the first file. A subroutine for reading the rest of the files is also included in this first file, which contains records that are 80-column card images. The first data set for each sounding contains data for the significant levels, without pressure contact or thermal lag correction. This was done in order to preserve the "raw", uncorrected data so that the user might apply a correction scheme of him own if desired. The second data set contains the same data with corrections applied for baroswitch contact error, and thermistor and hygristor thermal lag errors. The last three sets contain three types of interpolated data.

The microfilm output contains both plotted data, consisting of plots of temperature, dew point, and relative humidity on a pseudo-adiabatic chart, and tabular data. There are four tabular data sets for each sounding: (1) data for the significant levels without correction, (2) data with corrections, (3) data interpolated at 10mb p* intervals $0 \leq p^* \leq 500$mb, and (4) data interpolated at mandatory pressure levels.

3. Start Date: 19690501

4. Stop Date: 19690731

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5. Coverage:

a. Southernmost Latitude: 7.0S
b. Northernmost Latitude: 18.0N
c. Westernmost Longitude: -60.0W
d. Easternmost Longitude: -52.0E

6. How to Order Data:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: **NCDC.Orders@noaa.gov**

7. Archiving Data Center:

Archive Branch
National Climatic Data Center
151 Patton Avenue
Asheville, NC 28801

8. Technical Contact:

National Climatic Data Center
151 Patton Avenue
Asheville, NC 28801

9. Known Uncorrected Problems: None.

10. Quality Statement:

11. Essential Companion Datasets:

12. References:

Appendix

Table 2

0 °C, No humidity
1 °C, Relative humidity
2 °C, Difference between dry- and wet-bulb temperatures
3 °C, Difference between dry-bulb and dewpoint temperatures
4 °C, Dewpoint

Table 3

1 Sunday
2 Monday
3 Tuesday
4 Wednesday
5 Thursday
6 Friday
7 Saturday
:
:

Table 4

North Latitude
0 0° - 90°W
1 90° - 180°W
2 180° - 90°E
3 90° - 0°E
South Latitude
5 0° - 90°W
6 90° - 180°W
7 180° - 90°E
8 90° - 0°E

Table 6

0 Cloud amount less than 1/8
1 Cloud amount at least 1/8, with either 1/8 to 4/8 above or 1/8 to 4/8 below, or combination thereof
2 Cloud amount more than 4/8 above and 0 to 4/8 below
3 Cloud amount 0 4/8 above and more than 4/8 below
5 Chaotic sky; many undefined layers
6 In and out of clouds; on instruments 25 percent of the time
7 In and out of clouds; on instruments 50 percent of the time
8 In and out of clouds; on instruments 75 percent of the time
9 In clouds all the time; continuous instrument flight
/ Impossible to determine due to darkness

Table 7

0 Spot wind
Last fix 25 nmi prior to position.
1 Winds average over 100 nmi preceding last fix.
2 Winds average over 200 nmi preceding last fix.
3 Winds average over 300 nmi preceding last fix.
4 Winds average over 400 nmi preceding last fix.
Last fix 75 nmi prior to this position.
5 Winds average over 100 nmi preceding last fix.
6 Winds average over 200 nmi preceding last fix.
7 Winds average over 300 nmi preceding last fix.
8 Winds average over 400 nmi preceding last fix.
9 Winds average over more than 400 nmi.

Table 8

0 90 to 100 percent reliable
1 75 to 100 percent reliable
2 80 to 100 percent reliable
3 75 to 90 percent reliable
4 60 to 80 percent reliable
5 50 to 75 percent reliable
6 Less than 50 percent reliable
7 No reliability
8 No wind

:
:

9 Not used

Table 9

0 Clear (no cloud at any level)
1 Partly cloudy (scattered or broken)
2 Continuous layer(s) of cloud(s)
3 Sandstorm, duststorms, or storm of drifting snow
4 Fog, thick dust, or haze
5 Drizzle
6 Rain
7 Snow or rain and snow mixed
8 Shower(s)
9 Thunderstorm(s)

Table 10

0 No remarks
1 Light intermittent
2 Light continuous
3 Moderate intermittent
4 Moderate intermittent
5 Heavy intermittent
6 Heavy continuous
7 With rain
8 With snow
9 With hail

Table 11

0 Surface pressure in whole millibars; thousands figure omitted
1 Altitude of 1,000 mb surface is decameters or tens of feet; if negative, add 500
2 Altitude of 850-mb surface is decameters or tens of feet; if negative, add 500
3 Altitude of 700-mb surface in decameters or tens of feet.
4 Altitude of 500-mb surface in decameters or tens of feet.
5 Altitude of 300-mb surface in decameters or tens of feet.
6 Altitude of 200-mb surface in decameters or tens of feet.
7 Altitude of 100-mb surface in decameters or tens of feet.
8 True altitude (radio altimeter or other method) minus pressure altitude (set at 1,013-mb) in tens of feet; if negative, add 500 to absolute value (e.g., minus 100 is reported as 600)
9 Altimeter subscale reading in whole millibars; thousands figure omitted.

Table 12

0 zero	Zero
1 1/10 or less, but not zero	1 Okta or less, but not zero
2 2/10 and 3/10	2 Oktas
3 4/10	3 Oktas
4 5/10	4 Oktas
5 6/10	5 Oktas
6 7/10 and 8/10	6 Oktas

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7 9/10 or more, but not 10/10 7 Oktas
8 10/10 8 Oktas
9 Sky obscured, or cloud amount cannot be estimated

Table 13

0 Cirrus (Ci)
1 Cirrocumulus (Cc)
2 Cirrostratus (Cs)
3 Alto cumulus (Ac)
4 Altostratus (As)
5 Nimbostratus (Ns)
6 Stratocumulus (Sc)
7 Stratus (St) or Fractostratus (Fs)
8 Cumulus (Cu) or Fractocumulus (Fc)
9 Cumulonimbus (Cb)
/ Cloud not visible owing to darkness, fog, duststorm, sandstorm, or other analogous phenomena.

Table 14

00 Less than 100 ft (30 m)
01 100 ft (30 m)
02 200 ft (60 m)
03 300 ft (90 m)
04 400 ft (120 m)
05 500 ft (150 m)
49 4,900 ft (1,470 m)
50 5,000 ft (1,500 m)
51 Not specified, etc.
56 6,000 ft (1,800 m)
57 7,000 ft (2,100 m), etc.
78 28,000 ft (8,400 m)
79 29,000 ft (8,700 m)
80 30,000 ft (9,000 m)
81 35,000 ft (10,500 m)
82 40,000 ft (12,000 m)
87 65,000 ft (19,500 m)
88 70,000 ft (21,000 m)
89 Above 70,000 ft (21,000 m)
// Unknown

Table 15

0 Calm or stationary (or at the station)
1 NE
2 E
3 SE
4 S
5 SW
6 W
7 NW
8 N
9 All directions, no definite direction, or unknown, or no report.

:
:

Table 16

0 Calm
1 1 to 3 knots
2 4 to 6 knots
3 7 to 10 knots
4 11 to 16 knots
5 17 to 21 knots
6 22 to 27 knots
7 28 to 33 knots
8 34 to 40 knots
9 41 to 47 knots or over

Table 17

0 Calm (glassy)
1 Calm (rippled)
2 Smooth (wavelets) (1 to 2 ft)
3 Slight (2 to 4 ft)
4 Moderate (4 to 8 ft)
5 Rough (8 to 13 ft)
6 Very rough (13 to 20 ft)
7 High (20 to 30 ft)
8 Very high (30 to 45 ft)
9 Phenomenal, as might exist at the center of a hurricane (over 45 ft)

Table 18

0 No change
1 Marked wind shift
2 Marked turbulence begins or ends
3 Marked turbulence change (not with altitude)
4 Precipitation begins or ends
5 Change in cloud form
6 Fog bank begins or ends
7 Warm front
8 Cold front
9 Front, type not specified

Table 19

0 No report
1 Reported at previous position
2 Occuring at present position
3 20 nmi
4 40 nmi
5 60 nmi
6 80 nmi
7 100 nmi
8 150 nmi
9 More than 150 nmi

Table 20

0 No report
1 Signs of hurricane

:
:

2 Ugly, threatening sky
3 Duststorm or sandstorm
4 Fog or ice fog
5 Waterspout
6 Cs cloud shield or bank
7 As or Ac cloud shield or blank
8 Line of heavy cumulus
9 Cb heads or thunderstorms

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